# United States Patent [19]

**Sullaway**

[11] **4,220,422**

[45] **Sep. 2, 1980**


[54] **LEG CLOSURE**


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[21] Appl. No.: **914,468**

[22] Filed: **Jun. 12, 1978**

[51] **Int. Cl.**[2] ..... **B63C 23/16**; E02D 5/52

[52] **U.S. Cl.** ..... **405/225**; 405/227

[58] **Field of Search** ..... 405/195–209, 405/224–228; 38/89, 90



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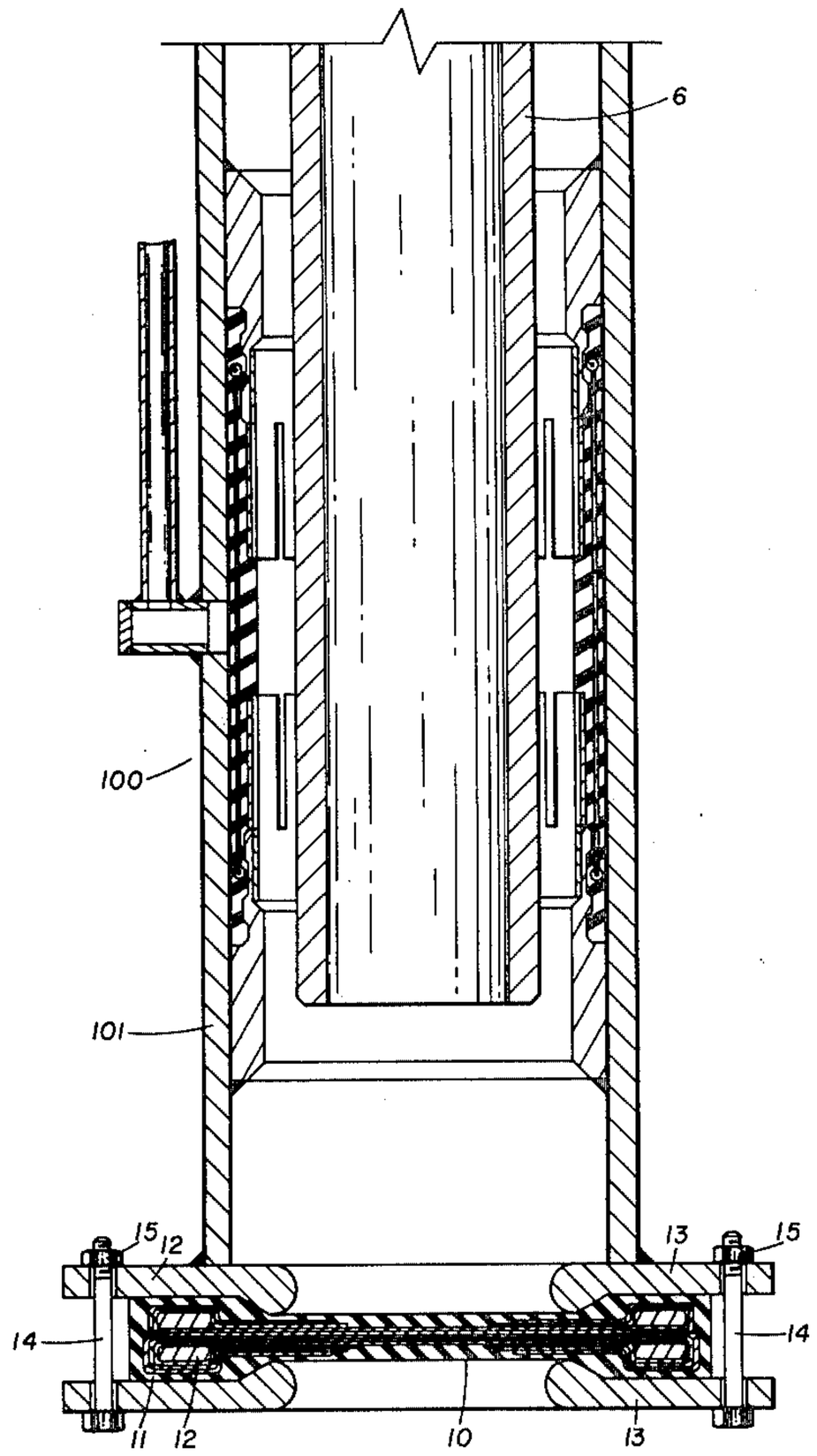
[57] **ABSTRACT**

A diaphragm for closing the bore of a tubular piling guide member and/or supporting leg member of a marine platform or similar structure, the diaphragm comprising reinforced elastic material wrapped around and bonded to a plurality of reinforcing members in the diaphragm with the diaphragm being positively secured to the guide member and/or leg of the platform by means of two flat annular plates having fasteners retaining the diaphragm therebetween.


**12 Claims, 4 Drawing Figures**



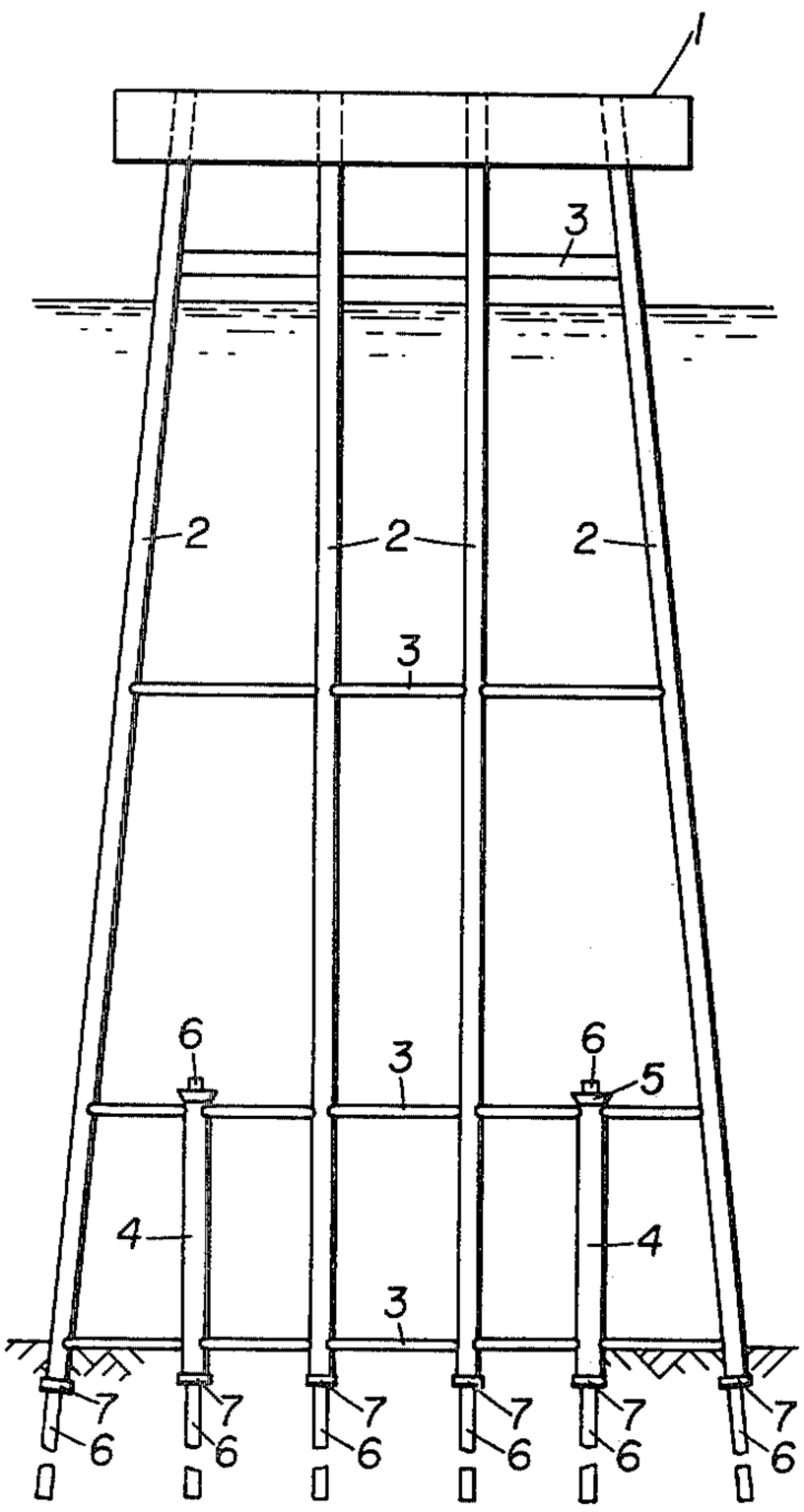



FIG. 1

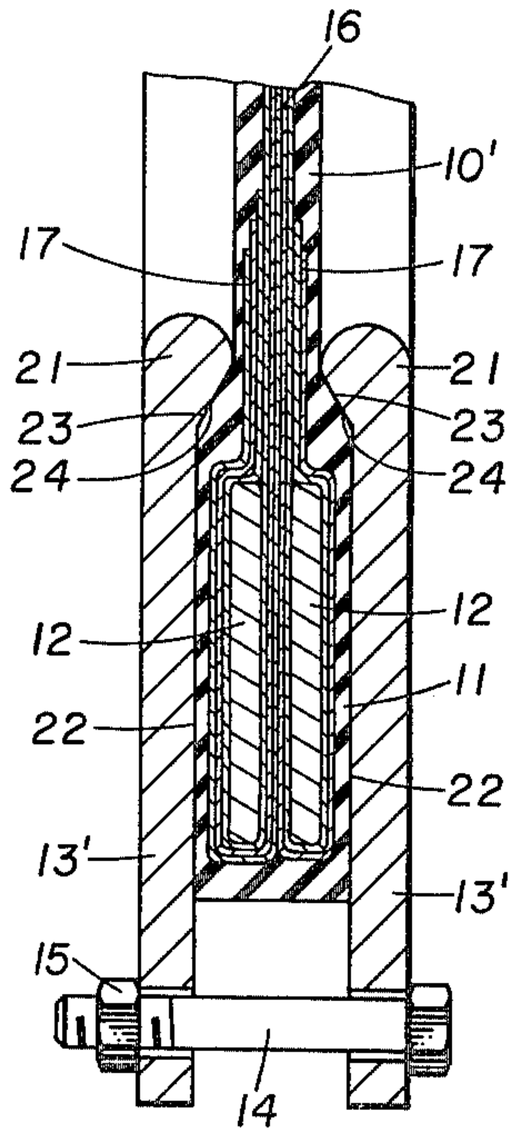



FIG. 4

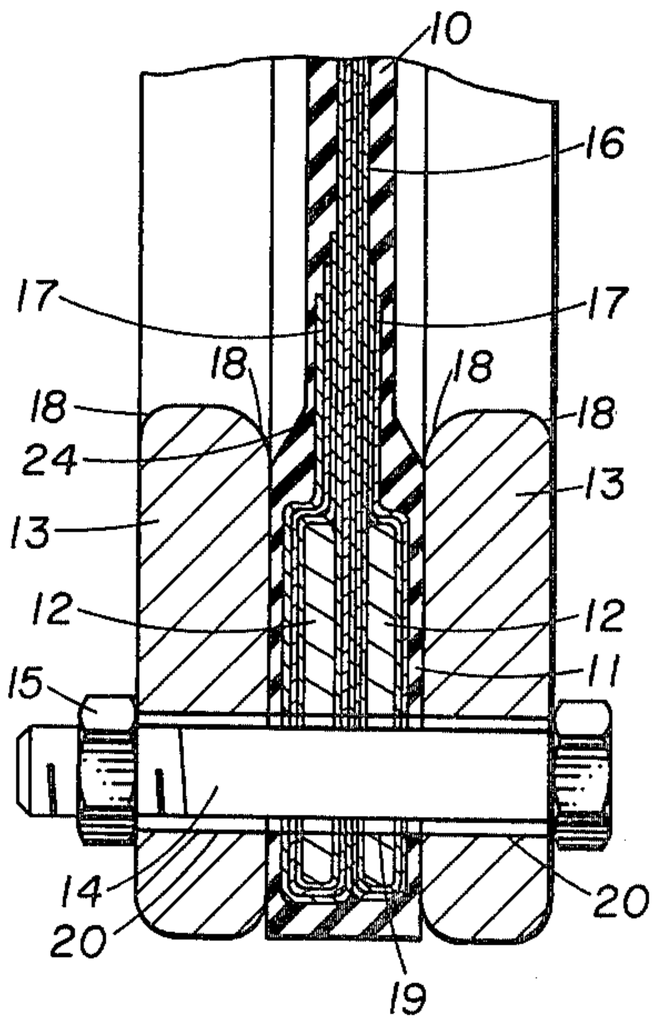



FIG. 3

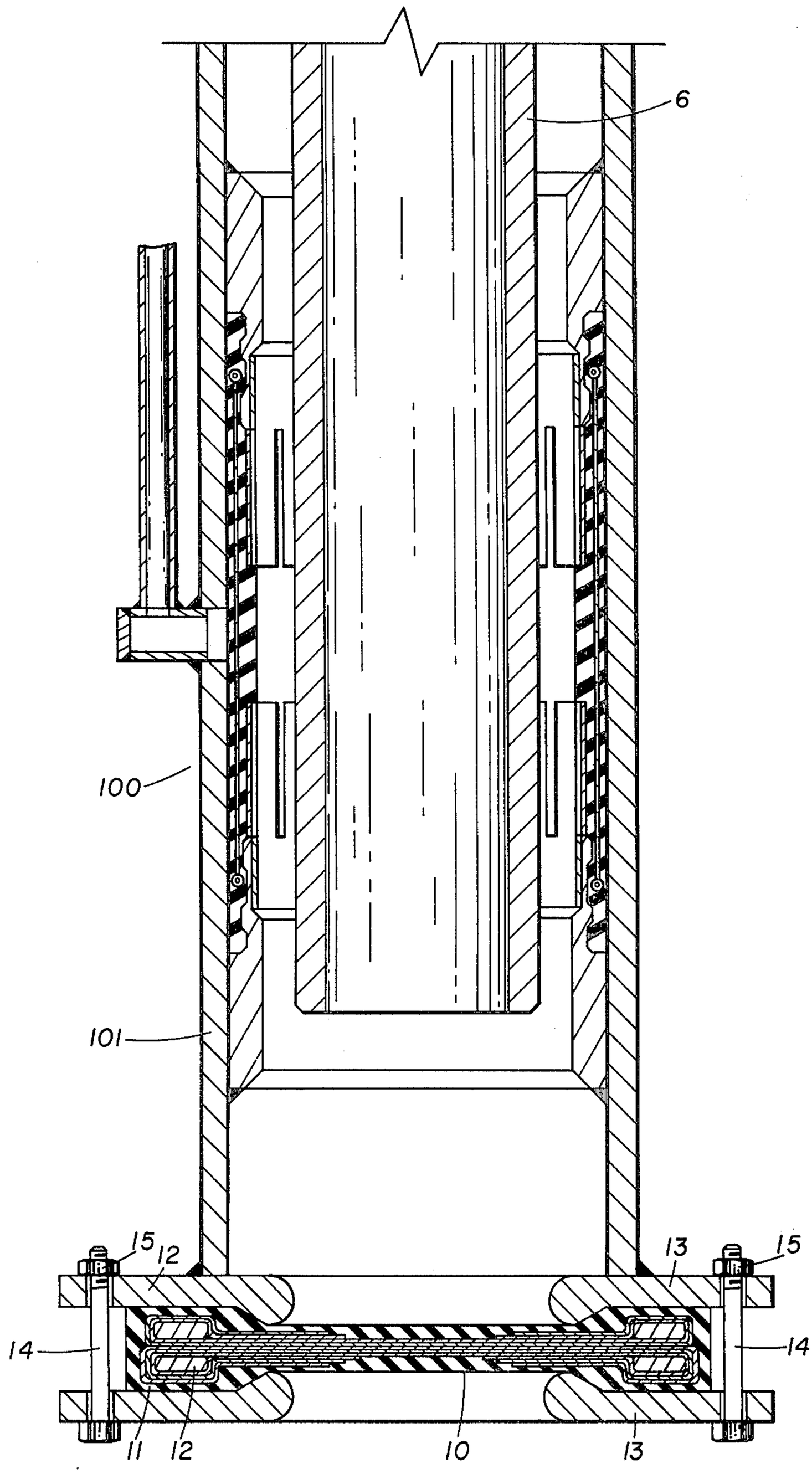



FIG. 2

# LEG CLOSURE

This invention relates to improved closure diaphragms for offshore platforms used in well drilling and production.

Offshore platforms are generally fabricated in a harbor or on a shore location and are then towed to a marine site where they are tipped on end and lowered into position with the platform resting on the ocean floor. The platform legs are hollow structures having open ends so that pilings can be driven downwardly through the legs into the subterranean formations below the ocean floor to anchor the platform in position.

It is desirable during platform setting operations to exclude foreign material from the platform leg to prevent the annulus between the piling and platform leg from becoming contaminated with foreign material which would prevent filling of the annulus with cement or grout. Therefore, a closure structure which is easily severable when the piling is driven through the platform leg is used to seal the end of the platform leg during setting of the platform.

One type of prior art leg closure as illustrated in U.S. Pat. No. 3,533,241 comprises a circular diaphragm of reinforced elastic material having an annular reinforcing element of circular cross-sectional shape molded in the periphery of the diaphragm with the diaphragm being secured to the leg of the platform by means of two annular plates, each plate having an annular groove of semi-circular cross-sectional shape therein for confining the annular reinforcing element in the periphery of the diaphragm between the two annular plates. The semi-circular grooves in the two annular plates are of slightly less radial diameter than the periphery of the diaphragm having the annular reinforcing element therein to confine the diaphragm periphery between the two annular plates by slightly deforming it. The reinforcing plies in the diaphragm are alternately wrapped and bonded about the reinforcing element in the periphery of the diaphragm to form a bead of circular cross-sectional shape about the diaphragm periphery without the ends of the plies extending into the inner portion of the diaphragm.

While the leg closure illustrated in U.S. Pat. No. 3,533,241 is of simple construction, the leg closure requires the two annular plates have the semi-circular grooves machined therein which for large diameters of leg closures can be difficult and requires the plies having the reinforcing cords therein be alternately wrapped and bonded about the annular reinforcing member which can cause handling problems during molding of the leg closure.

Another type of leg closure as illustrated in U.S. Pat. No. 4,024,723 comprises a circular diaphragm of reinforced elastic material having an annular reinforcing element being of a teardrop cross-sectional shape molded in the periphery of the diaphragm and having a ring of downwardly facing cutter blades molded in the upper surface of the diaphragm to sever the diaphragm when a piling is driven therethrough with the diaphragm being secured to the leg of the platform by means of two annular plates with one plate having an annular groove therein for confining the annular reinforcing element in the periphery of the diaphragm between the two annular plates.

While the leg closure of U.S. Pat. No. 4,024,723 is relatively simple to construct, it requires the addition of cutter blades to be molded in the leg closure which offer resistance when driving the piling through the leg closure and requires the machining of a circular cross-sectional shaped groove in at least one of the two annular plates securing the diaphragm to the leg or sleeve.



In contrast to the prior art leg closures, the leg closure of the present invention comprises a diaphragm of reinforced elastic material wrapped and bonded about one or more reinforcing members in the periphery of the diaphragm with the diaphragm being secured to the leg of the platform by means of two annular plates with the annular plates either having flat confronting faces which have fasteners retaining the diaphragm therebetween via holes therein or having flat confronting faces with inwardly tapered enlarged ends to retain the leg closure therebetween by means of an interference fit therewith.

The advantages and the preferred embodiments of the present invention will be understood from the following specification taken in conjunction with the accompanying drawings wherein:

FIG. **1** is a side elevational view of a marine drilling platform having tubular supporting legs and piling guides between the legs resting on the bottom of a body of water with the present invention installed on the lower end of the legs and guides.

FIG. **2** is a cross-sectional view of the present invention in a typical installation in a leg or piling guide.

FIG. **3** is an enlarged broken cross-sectional view of a preferred embodiment of the present invention.

FIG. **4** is an enlarged broken cross-sectional view of an alternative preferred embodiment of the present invention.

Referring to FIG. **1**, the present invention is shown installed on a marine platform. A marine platform **1** having tubular supporting legs **2** between which horizontal reinforcing members **3** are connected in the usual manner. Tubular piling guides or piling sleeves **4**, which may have flared upper ends **5**, are supported between the lower end portion of the legs **2** by the lower reinforcing members **3** and, with the legs, are adapted to rest upon or have their lower extremities slightly embedded in the bottom of a body of water.

The guides **4** or legs **2** are secured to the earth by driving piling **6** to refusal into the bottom of the body of water. Upon completion of the pile driving, the annulus between each guide **4** and/or leg **2** and its associated piling **6** may be filled with cement or grout to provide a unitary base structure.

Contained on the bottom of each leg **2** and guide **4** is a rupturable seal assembly **7** which embodies the principles of the present invention.

Referring to FIG. **2**, the seal assembly **7** is shown in relation to an inflatable packer assembly **100** installed at the bottom of a leg **2** or guide **4**. As shown, the diaphragm **10** is relatively thin compared to its diameter and has in its periphery **11** one or more metal reinforcing members **12**.

For mounting the seal assembly **7** on the lower end of the inflatable packer assembly **100**, a pair of flat, annular plates **13** is provided which are adapted to be detachably connected about their outer periphery by a plurality of bolts **14** and nuts **15**. The upper annular plate **13** is adapted to be secured to the lower end of the packer housing **101** by welding, although any suitable means of securing the plate **13** may be used. If no inflatable packer is installed on the bottom of the leg **2** or guide **4**,

alternatively, the plate **13** may be secured to the bottom of the leg **2** or guide **4**.

As shown, the seal assembly closes the lower end of the inflatable packer assembly **100** which is secured to a leg **2** or guide **4** through which piling is to be driven to facilitate floating of the platform to its point of installation as well as prevent entrance of slit and other debris into the leg **2** or guide **4** during the installation of the platform. To position the platform legs **2** and guides **4** on the bottom of the body of water, it is necessary to water flood some or all of the legs **2** and guides **4**. After rupturing of the diaphragm **10** by the piling **6** being driven into the bottom, the diaphragm **10** and the water located thereabove acts to help prevent entry of foreign material into the leg **2** or guide **4**, although during driving of the piling **6** an amount of foreign material will be introduced into the leg **2** or guide **4**.

Referring to FIG. **3**, a preferred embodiment of the diaphragm **10** is shown. The diaphragm **10** comprises a flexible member of rubber, synthetic rubber or other suitable elastomeric material. To reinforce the diaphragm **10**, a plurality of layers **16** of fabric are bonded in the diaphragm **10** with the outer periphery of the layers **16** of fabric being wrapped and bonded to metal reinforcing members **12**. Any number of layers of fabric may be used to reinforce the diaphragm **10** depending upon the desired strength of the diaphragm, although six (6) layers of fabric are shown. The layers **16** of fabric used to reinforce the diaphragm **10** may be of any suitable material, such as rayon, nylon, steel, a fabric sold under the trademark Kevlar by the Du Pont Company, etc., although nylon is preferred.

The metal reinforcing members **12** are formed having a generally rectangular cross-sectional configuration. Although the thickness of the metal reinforcing member **12** may vary, when considering the cross-sectional thickness of the member in proportion to the cross-sectional width of the member, the ratio of cross-sectional thickness to cross-sectional width of each member **12** should generally be in the range of 1:50 to 1:1, preferably in the range of 1:15 to 1:5, and most preferably approximately a 1:10 ratio. If the ratio of cross-sectional thickness to cross-sectional width of the metal reinforcing member **12** is greater than 1:50, such as 1:100, when the member **12** is highly stressed it will initially buckle inwardly causing a wrinkle in diaphragm **10**, thereby allowing fluid to enter the leg **2** or guide **4** until the loading on the diaphragm **10** is sufficient to tear the layers **16** of fabric which causes massive failure of the diaphragm **10**, not merely a leak between the annular flat plates **13**. While the flat, annular plates **13** securely retain the periphery **11** of the diaphragm **10** having the metal reinforcing members **12** therein to generally prevent buckling of the members **12** under loading, since the diaphragm **10** deflects one of the plates **13** under loading, the periphery **11** of the diaphragm **10** under high loading will generally allow the members **12** to buckle, if not sufficiently strong.

Although the diaphragm **10** may be formed having a single metal reinforcing member **12** molded in the outer periphery **11** of the diaphragm **10** with the layers **16** of fabric wrapped and bonded thereto, it is preferable to use a plurality of metal reinforcing members **12** in the outer periphery **11** since a plurality of reinforcing members **12** provide a greater surface area for the bonding of the layers **16** of fabric to the reinforcing members **12**. Although only two metal reinforcing members **12** have been shown in the outer periphery **11** of the diaphragm **10**, any desired number may be used as long as sufficient strength is present in the outer periphery **11** of the diaphragm **10** to resist buckling under anticipated loading.

It should also be noted that it is important to have the ends **17** of the layers **16** of the fabric used to reinforce the diaphragm **10**, which are wrapped and bonded to the metal reinforcing members **12**, extend a distance into the inner portion of the diaphragm when they are bonded in position. When the diaphragm **10** is deflected by the force of the water, the inner portion of the outer periphery **11** contacts the inner radiused edge **18** of the annular flat plate **13** secured to the packer housing **101**. By having the ends **17** of the layers **16** of the fabric reinforcing the diaphragm **10** terminating inwardly of the annular flat members **13** after they are wrapped and bonded to the metal reinforcing members **12**, this acts as additional reinforcement for the diaphragm **10** to help prevent any failure of the diaphragm by tearing of the layers **16** of fabric at the outer periphery **11** of the diaphragm **10** which is retained between the annular flat plates **13**.

It should be noted that the inner edges **18** of the annular flat plates **13** are radiused to provide a smooth bearing surface for the diaphragm **10** to bear against under loading.

The diaphragm **10** is positively held between the annular flat plates **13** by means of bolts **14** and nuts **15** extending therethrough. The diaphragm **10** is initially formed having the outer periphery **11** without bolt holes **19** therein as well as the annular flat plates **13** being initially formed without holes **20** therein to facilitate construction of both the diaphragm **10** and annular flat plates **13**. After manufacture, the diaphragm **10** and flat annular plates **13** either have the holes **19** and **20**, respectively, drilled therein or the diaphragm **10** is assembled between the pair of annular flat plates **13** and has the holes **19** and **20**, respectively, drilled therein during a single drilling operation. The annular flat plates **13** may be formed having any desired cross-sectional thickness and cross-sectional width provided that the cross-sectional width is at least as great as the cross-sectional width of the metal reinforcing members **12** in the periphery **11** of the diaphragm **10**.

Referring to FIG. **4**, an alternative embodiment of the present invention is shown. The diaphragm **10'** is identical to the diaphragm **10** shown in FIG. **3** except the diaphragm **10'** contains no holes **19** therein. The annular flat plates **13'** are formed having enlarged portions **21** thereon. The enlarged portions **21** on the annular flat plates **13'** are formed by machining surfaces **22** of the annular flat plates **13'** to have an angular surface **23** located thereon. The angular surface **23** on the annular flat plates **13'** can be formed at any angle with respect to the surface **22**, although a 15 degree angle is normally used. It should be noted that it is only necessary to provide a slight interference between the enlarged ends **21** of the annular flat plates **13'** and the diaphragm **10'** to retain the diaphragm **10'** therein. It should also be noted that the angle on the angular surface **23** should match the angular surface **24** on the diaphragm **10'**.

In this connection, as shown the diaphragms **10** and **10'** are formed having the periphery **11** being thicker than the inner portion thereof to facilitate the driving of the piling therethrough. Although the diaphragms **10** and **10'** could be formed having a constant thickness, the excess amount of elastic material in the inner portion of the diaphragm would offer increased resistance to the driving of a piling therethrough. Therefore, both dia-

phragms 10 and 10' are formed having outer periphery 11 being of greater thickness than the inner portion of the diaphragm with the angular surface 24 of each diaphragm defining the transitional portion of the diaphragm between the outer periphery 11 and inner portion.

It is to be clearly understood that the construction of diaphragms 10 and 10' is identical except diaphragm 10 has holes 19 therein to permit the diaphragm to be positively retained between flat annular plates by the use of fasteners.

From the foregoing it should be readily apparent that the present invention offers important advantages over the prior art.

The diaphragm is easily constructed using simple wrapping of the layers of fabric reinforcing the diaphragm around the metal reinforcing members in the outer periphery of the diaphragm.

The annular flat plates retaining the diaphragm have simple shapes requiring little machining for use.

The diaphragm is positively retained between the annular flat plates to prevent release therefrom.

The diaphragm is of a reinforced type capable of withstanding relatively high pressures over relatively large areas while remaining readily frangible by a piling driven therethrough without requiring the addition of cutting members in the diaphragm.

The metal reinforcing members in the periphery of the diaphragm are simple geometric shapes which can be easily constructed.

The diaphragm can be used with a variety of types of annular flat plates to retain the diaphragm on the leg or guide.

Having thus described my invention, I claim:

1. In combination, a diaphragm and annular diaphragm retaining means retaining said diaphragm therein, wherein said diaphragm comprises:

circular flexible member means having a peripheral portion and an inner portion;

annular reinforcing member means located in the peripheral portion of said circular flexible member means;

reinforcing means having a peripheral portion and an inner portion contained witnin said circular flexible member means, said reinforcing means having the inner portion thereof being disposed within the inner portion of said circular flexible member means, having the peripheral portion thereof being wrapped and secured to said annular reinforcing member means and having the peripheral portion of said reinforcing means terminating inwardly of said reinforcing member means and the inner diameter of said annular diaphragm retaining means wherein a portion of the peripheral portion of the reinforcing means overlays a portion of the inner portion of said reinforcing means.

2. The combination of claim 1 wherein:

said reinforcing means comprises a plurality of layers of reinforcing means; and

said annular reinforcing member means comprises a plurality of annular reinforcing member means, each annular reinforcing member means of said plurality of annular reinforcing member means having at least one layer of said plurality of layers of reinforcing means being wrapped and secured thereto.

3. The combination of claim 2 wherein:

said plurality of layers of reinforcing means comprise a plurality of layers of fabric; and

said plurality of reinforcing member means comprise a plurality of annular substantially rectangular cross-sectionally shaped reinforcing member means.

4. The combination of claim 3 wherein:

said diaphragm is retained by said diaphragm retaining means by means of a plurality of fasteners extending through said diaphragm retaining means, through said circular flexible member means, through said annular reinforcing member means of said diaphragm and through said reinforcing means of said diaphragm.

5. The combination of claim 3 wherein:

said diaphragm is retained by said diaphragm retaining means by means of an interference fit therein.

6. In combination, a diaphragm and an annular diaphragm retaining means retaining said diaphragm therein for closing the bore of a tubular support member of a marine platform or a similar structure, said diaphragm comprising:

circular flexible member means having a peripheral portion and an inner portion;

annular reinforcing member means located in the peripheral portion of said circular flexible member means;

reinforcing means having a peripheral portion and an inner portion contained within said circular flexible member means, said reinforcing means having the inner portion thereof being disposed within the inner portion of said circular flexible member means, having the peripheral portion thereof being wrapped and secured to said annular reinforcing member means and having the peripheral portion of said reinforcing means terminating inwardly of said reinforcing member means and the inner diameter of said annular diaphragm retaining means wherein a portion of the peripheral portion of the reinforcing means overlays a portion of the inner portion of said reinforcing means; and

said annular diaphragm retaining means comprising:

a pair of annular plates releasably secured to each other retaining said diaphragm therebetween, said annular diaphragm retaining means having one of said pair of annular plates secured to the bottom of a tubular support member of said marine platform or said similar structure thereby closing said bore of said tubular support by said diaphragm and said diaphragm retaining means being installed thereon.

7. The combination of claim 6 wherein:

said reinforcing means comprises a plurality of layers of reinforcing means; and

said annular reinforcing member means comprises a plurality of annular reinforcing member means, each annular reinforcing member means of said plurality of annular reinforcing member means having at least one layer of said plurality of reinforcing means being wrapped and secured thereto.

8. The combination of claim 7 wherein:

said plurality of layers of reinforcing means comprises a plurality of layers of fabric; and

said plurality of annular reinforcing member means comprises a plurality of annular substantially rectangular cross-sectionally shaped reinforcing member means.

9. The combination of claim 8 wherein:

said pair of annular plates are releasably secured to each other by a plurality of fasteners extending through said pair of annular plates, through said flexible member means, through said reinforcing means of said diaphragm and through said reinforcing means of said diaphragm.

**10**. The combination of claim **8** wherein:

said pair of annular plates are releasably secured to each other by a plurality of fasteners extending through said pair of annular plates while said diaphragm is retained between said pair of annular plates by means of an interference fit.

**11**. In combination, a diaphragm and an annular diaphragm retaining means retaining said diaphragm therein for closing the bore of a tubular support member of a marine platform or a similar structure,

said diaphragm comprising:

circular flexible member means having a peripheral portion and an inner portion;

annular reinforcing member means located in the peripheral portion of said circular flexible member means;

reinforcing means having a peripheral portion and an inner portion contained within said circular flexible member means, said reinforcing means having the inner portion thereof being disposed within the inner portion of said circular flexible member means, having the peripheral portion thereof being wrapped and secured to said annular reinforcing member means and having the peripheral portion of said reinforcing means terminating inwardly of said reinforcing member means and the inner diameter of said annular diaphragm retaining means wherein a portion of the peripheral portion of the reinforcing means overlays a portion of the inner portion of said reinforcing means; and

said annular diaphragm retaining means comprising:

a pair of annular plates releasably secured to each other by a plurality of fasteners extending through said pair of annular plates, through said circular flexible member means, through said reinforcing member means of said diaphragm and through said reinforcing means of said diaphragm, said annular diaphragm retaining means having one of said pair of annular plates secured to the bottom of a tubular support member of said marine platform or said similar structure thereby closing said bore of said tubular support by said diaphragm and said diaphragm retaining means being installed thereon.

**12**. In combination, a diaphragm and an annular diaphragm retaining means retaining said diaphragm therein for closing the bore of a tubular support member of a marine platform or a similar structure,

said diaphragm comprising:

circular flexible member means having a peripheral portion and an inner portion;

annular reinforcing member means located in the peripheral portion of said circular flexible member means;

reinforcing means having a peripheral portion and an inner portion contained within said circular flexible member means, said reinforcing means having the inner portion thereof being disposed within the inner portion of said circular flexible member means, having the peripheral portion thereof being wrapped and secured to said annular reinforcing member means and having the peripheral portion of said reinforcing means terminating inwardly of said reinforcing member means and the inner diameter of said annular diaphragm retaining means wherein a portion of the peripheral portion of the reinforcing means overlays a portion of the inner portion of said reinforcing means; and

said annular diaphragm retaining means comprising:

a pair of annular plates releasably secured to each other by a plurality of fasteners extending through said pair of annular plates while said diaphragm is retained between said pair of annular plates by means of an interference fit, said annular diaphragm retaining means having one of said pair of annular plates connected to the bottom of a tubular support member of said marine platform or said similar structure thereby closing said bore of said tubular support by said diaphragm and said diaphragm retaining means being installed thereon.

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